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BIOLOGICAL EVALUATION
Spruce Beetle Winter Mortality

Fort Apache Indian Reservation
Arizona

1971

Prepared by:

Robert H. Frye
Robert H. Frye, Entomologist
Branch of Forest Pest Control

APPROVED BY:

F. M. Yasinski
F. M. Yasinski, Chief
Branch of Forest Pest Control

Mark M. Johannesen
Mark M. Johannesen
Assistant Regional Forester

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Introduction

On January 27 and February 2 and 3, 1971, a biological evaluation was conducted on the Fort Apache Indian Reservation to determine the effects of cold temperatures on the epidemic spruce beetle population. The evaluation was conducted under the direction of Harold Flake and Bob Frye, Region 3 entomologists.

During the week of January 1, 1971, record low temperatures occurred in the Southwest. The official low for Hawley Lake, Arizona, which borders the spruce beetle infestation on the Fort Apache Indian Reservation, was -40° F. This was the lowest temperature ever recorded in Arizona. The below normal snow level of 1-3 feet offered little protection to the beetles in the lower bole. Spruce beetle mortality due to low temperatures has been an important factor in reducing past epidemic populations. Low temperatures were fatal to 75 percent of the larvae in Colorado in 1951 (Massey and Wygant 1954), and to 42 percent of the brood in Idaho and Montana in 1953-1954 (Terrell 1954).

Results of the biological evaluation for winter mortality showed an 89.7 percent reduction in the larval population in Ord, Smith, and Paradise drainages. The number of surviving larvae in Ord and Paradise indicates a non-treatable situation. The population on Smith was treatable, but small enough to be marginal. The larval mortality and population trend does not support the methods of suppression in our recommendations of October 16, 1970.

Technical Information

Insect - Spruce beetle, *Dendroctonus rufipennis* (Kirby)

Host - Engelmann spruce, *Picea engelmannii* Parry

1970 Presuppression Survey Information for Sampled Drainages -

Drainage	Acres surveyed	No. 1969 infested trees	No. 1970 infested trees	Total
Ord	4,709	1,820	8,100	9,920
Smith	2,798	2,120	4,780	6,900
Paradise	5,754	8,800	9,900	18,700

Methods and Materials

Three sample sites were selected in each of three drainages (Ord, Smith, and Paradise), for a total of nine (Fig. 1). These areas were chosen because they were accessible and they contained high concentrations of infested trees. The three sample points within each drainage consisted of one area on or near a ridge top, another between the ridge and creek bottom, and one on a creek bottom. This was done since temperatures can be dependent on terrain. The samples were collected January 27 and February 2 and 3.

Within each sample site, five Engelmann spruce trees were selected. Trees which were successfully attacked in 1970 and were not heavily woodpeckered were randomly chosen. One exception was made at site 7, where only three trees were sampled because of chain saw difficulties. Snowshoes and snowmobiles were used to reach the sample sites.

An approximate 6X6-in. bark and wood sample was removed from the north and south side of each tree at breast height with a chain saw (Fig. 2). The samples were numbered and bagged in plastic bags and stored at 34° F. for a week. Before examination, the samples were exposed to room temperatures for a week. The samples were then measured and broken up to expose the larvae, pupae, and parent adults. Pupae were counted as live larvae since metamorphosis had occurred while the samples were exposed to room temperatures. The number of larvae and adults per sample were converted to numbers per quarter square foot (6X6-in.) for more accurate and standard comparisons. The following formula was used for this conversion:

$$\text{No. of larvae or adults/6X6-in. bark sample} = \frac{0.25\ \text{ft}^2(\text{No. of larvae or adults/sample})}{\text{size of sample (ft}^2)}$$

Total larvae, live larvae and percent mortality, were statistically analyzed using a one-way analysis of variance. If significance occurred, the means were compared with Duncan's New Multiple Range test. All statistical tests were performed at the 0.05 significance level. Percent mortality was transformed to arcsin values for analysis.

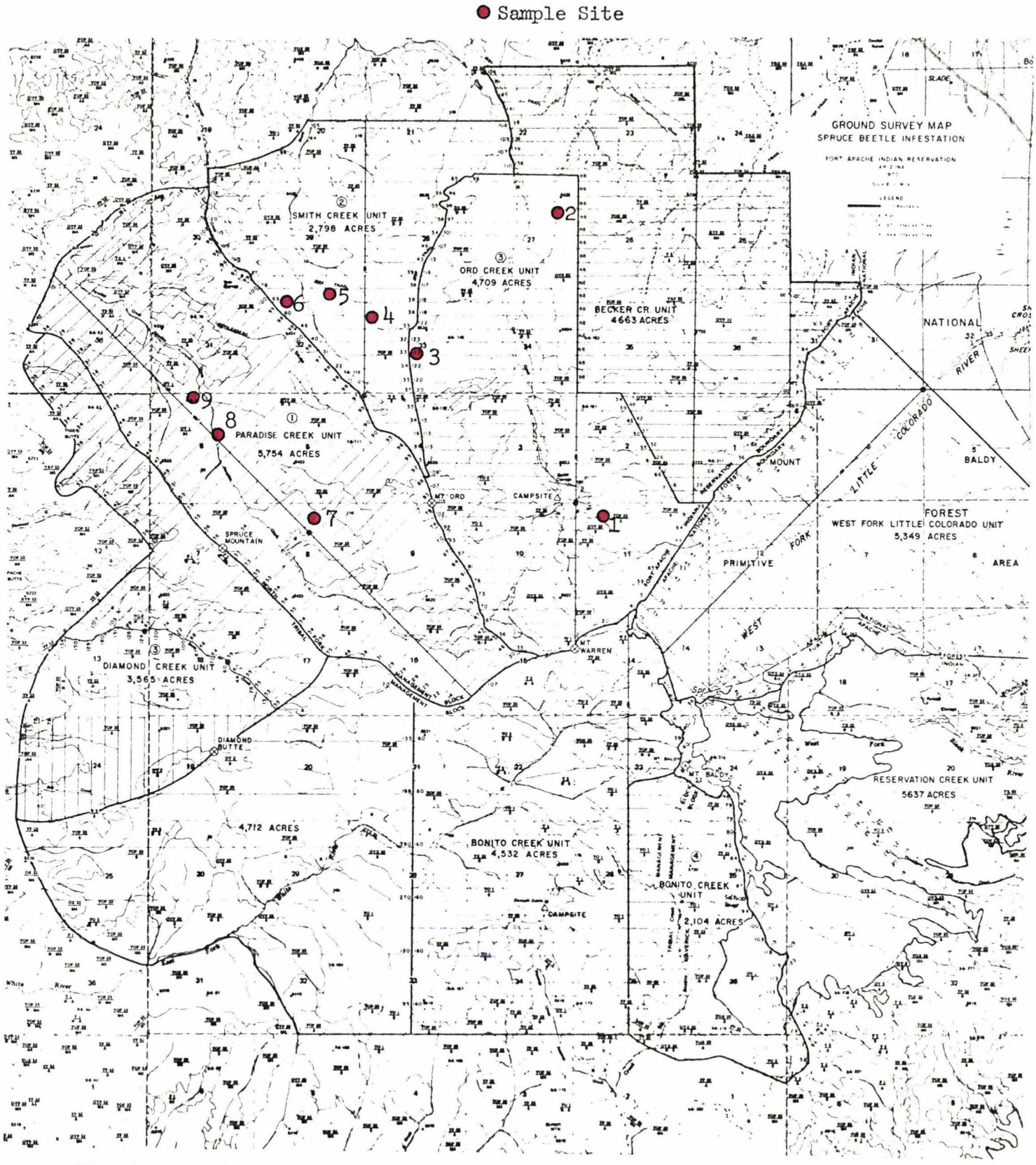

Fig. 1.--The biological evaluation sample sites for spruce beetle winter mortality. 1971.

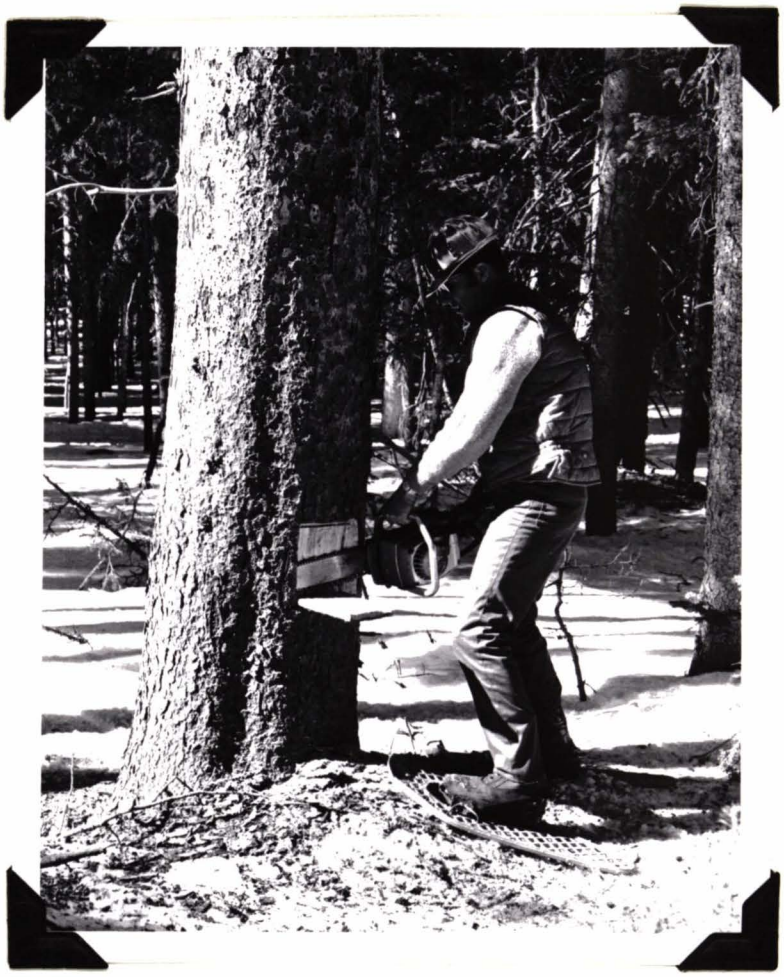

Fig. 2.--The method used to remove bark samples from infested trees.

Results

A total of 1,413 larvae were collected. Dead larvae were grey to black-colored, which is normal for cold-killed larvae (Fig. 3). Brood mortality was observed in each sample containing larvae. Mortality was observed in both the cambial area and also within the bark. The percent larval mortality for Ord, Paradise, and Smith was 96.1, 92.2, and 76.8 percent, respectively (Table 1). The overall mortality was 89.7 percent, with a mean confidence interval of 82.7 to 95.1 percent.

The total number of larvae (live and dead) per drainage did not differ significantly (Analysis of variance, Appendix 4). It may be assumed that the 1970 brood population did not differ between drainages before the low temperatures occurred and that the drainages were equally sampled.

The total number of larvae (both live and dead) per 6X6-in. bark sample, when fitted to Knight's (1960a) sequential sample plan, indicated that populations in all three drainages were treatable (Table 1). According to Knight, if the average number of larvae per quarter square foot (6X6-in.) is five or more, the population is treatable. If the count is lower than four, then a non-treatable situation exists. The count of live and dead larvae for Ord, Paradise, and Smith was 11.1, 10.3, and 15.8, respectively.

The effects of cold-caused mortality are best shown in the average number of live larvae per 6X6-in. bark sample (Table 1). Live larvae per 6X6-in. sample was 1.0, 1.8, and 6.0 for Ord, Paradise, and Smith, respectively. Smith was the only drainage to have a larval population high enough to be considered treatable. The difference is substantiated by an analysis of variance (Appendix 6). Smith was significantly higher than both Ord and Paradise, which did not differ from each other.

Discussion

The influence of beneficial organisms may be amplified because of low temperatures. During cold temperatures in Idaho and Montana, Terrell (1954) reported that the parasite-predator complex associated with the spruce beetle, although injured by the low temperatures, suffered relatively less than the spruce beetles. The same observations were made on the Reservation. Woodpecker feeding, the most significant predation affect, was not measured since woodpeckered trees were not sampled. Because of the high beetle mortality, the woodpeckers will be under more stress, resulting in concentrated feeding where beetle survival is present. Woodpeckers will also

Fig. 3.--Normal spruce beetle larvae as compared to black, cold-killed larvae.

Table 1.--Number of larvae in 6X6-in. bark samples collected Jan. 27 and Feb. 2, 3, 1971.

Drainage	Avg/6X6-in. bark sample		
	Total larvae	Live larvae	% mortality
Ord	11.1[a]	1.0[b]	96.1
Paradise	10.3[a]	1.8[b]	92.2
Smith	15.8[a]	6.0[a]	76.8
Overall	12.5 ± 3.3[a]	3.0 ± 1.8[b]	89.7 (82.7-95.1)

[a] Considered treatable according to June sequential sample plan.
[b] Considered not treatable according to June sequential sample plan.

be forced to feed lower on the bole than normal (Knight and McCambridge 1951). We can, therefore, expect a greater impact on the beetle population by woodpeckers.

Knight (1960) found in Colorado that insufficient beetles are produced in the basal 5 feet of the bole to reinfest a tree of the same diameter. Beetles must survive in relatively large numbers above the 5-foot level to supply the required number for maintaining an infestation. The snow level was low enough that beetle mortality occurred below the 5-foot level.

In some locations on the Reservation where beetles are present, the stand structure has changed to the detriment of the beetle. The highly preferred host trees are gone in some cases and the number reduced in most others, so the host material for a population buildup may be lacking. However, stand structure information is badly needed before a definite conclusion can be made.

The present information indicates that there is little chance for an immediate population buildup. For the present, a further decrease can be expected. Massey and Wygant (1954) have demonstrated in both field and laboratory tests that the adults are more susceptible to cold temperatures than larvae. Therefore, the adults in the 1969 infested trees that will fly this summer should have had a higher mortality rate than the 89.7 percent found for larvae. The attacking population should be light, especially with the added natural mortality that will occur.

Recommendations

Pest Control will sample all the remaining drainages within the infestation. Becker and Reservation drainages should be given top priority. Smith will be resampled to confirm the predicted trend toward an untreatable situation. The infested area on the adjoining Mount Baldy Wilderness Area, Apache National Forest, will also be evaluated to determine what effect it might have on the infestation.

The present population trend in the sampled drainages does not support our prior suppression recommendations. From an entomological basis, no direct suppression methods are needed for Ord, Paradise, or Smith drainages. A complete evaluation, re-evaluating our prior recommendations, will be made after the remaining drainages are sampled.

References Cited

Knight, F. B. 1960a. Sequential sampling of Engelmann spruce beetle infestations in standing trees. USDA Forest Serv. Res. Note RM-47. 4 p.

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Massey, C. L., and N. D. Wygant. 1954. Biology and control of the Engelmann spruce beetle in Colorado. USDA Cir. No. 944. 35 p.

Terrell, T. T. 1954. Mortality of the Engelmann spruce beetle brood during the winter of 1953-1954. USDA Forest Serv. Res. Note IM-10. 9 p.

Appendix 1.--Maximum and minimum temperatures from official weather bureau stations near the sampled areas.

		December 1970				January 1971											
		Day of Month															
		28	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12
Hawley Lake	Max.	38	38	40	40	53	48	34	14	15	16	22	25	37	40	46	46
	Min.	29	-2	-3	-1	3	10	9	-31	-34	-39	-40	-37	-17	-1	2	17
McNary	Max.	47	41	42	42	53	55	32	19	18	14	15	27	40	48	48	48
	Min.	30	11	12	14	18	21	12	-13	-18	-17	-19	- 8	2	11	20	26
Whiteriver	Max.	46	49	48	54	55	59	47	27	29	27	25	28	42	47	51	54
	Min.	38	25	20	19	27	24	18	- 8	- 9	- 9	-11	-10	3	19	22	22

Appendix 2.--Results of winter mortality samples collected on Jan. 27 and Feb. 2 and 3, 1971, on the Fort Apache Indian Reservation, Arizona.

Drainage	Sample area	Tree no.	Side sampled	Bark area sampled (ft^2)	Larvae			Parent adults		
					Live	Dead	% mortality	Live	Dead	% mortality
Ord	1	1	N	0.24	0	0	-	0	0	-
			S	0.22	0	0	-	0	0	-
		2	N	0.21	0	0	-	0	2	100
			S	0.22	0	0	-	0	0	-
		3	N	0.22	0	4	100	0	3	100
			S	0.24	1	23	95.8	0	1	100
		4	N	0.25	0	33	100	0	2	100
			S	0.25	2	20	90.9	0	6	100
		5	N	0.41	1	7	87.5	0	4	100
			S	0.34	0	14	100	0	0	-
Ord	2	1	N	0.26	0	0	-	0	0	-
			S	0.25	0	1	100	0	4	100
		2	N	0.28	0	6	100	0	5	100
			S	0.29	0	6	100	0	1	100
		3	N	0.29	0	35	100	0	1	100
			S	0.31	0	21	100	0	4	100
		4	N	0.29	0	56	100	0	6	100
			S	0.30	0	24	100	0	1	100
		5	N	0.30	0	16	100	0	8	100
			S	0.31	0	0	-	0	2	100

Appendix 2 (continued)

Drainage	Sample area	Tree no.	Side sampled	Bark area sampled (ft^2)	Larvae			Parent adults		
					Live	Dead	% mortality	Live	Dead	% mortality
Ord	3	1	N	0.31	0	0	-	0	1	100
			S	0.29	0	0	-	0	5	100
		2	N	0.33	2	33	94.3	0	3	100
			S	0.34	0	0	-	0	0	-
		3	N	0.35	0	0	-	0	0	-
			S	0.27	0	4	100	0	0	-
		4	N	0.29	11	1	8.3	0	2	100
			S	0.34	9	18	66.7	0	2	100
		5	N	0.38	7	42	85.7	0	4	100
			S	0.33	8	18	69.3	0	5	100
Smith	4	1	N	0.36	69	26	27.4	0	0	-
			S	0.33	47	9	16.1	0	0	-
		2	N	0.42	0	1	100	0	0	-
			S	0.39	0	0	-	0	0	-
		3	N	0.40	0	0	-	0	0	-
			S	0.34	0	0	-	0	3	100
		4	N	0.31	0	0	-	0	3	100
			S	0.34	0	0	-	0	0	-
		5	N	0.30	3	0	0	0	1	100
			S	0.39	0	0	-	0	0	-
Smith	5	1	N	0.34	0	0	-	0	0	-
			S	0.34	2	5	71.4	1	2	66.7
		2	N	0.33	2	4	66.7	0	0	-
			S	0.35	0	0	-	0	0	-
		3	N	0.42	44	29	39.7	0	1	100
			S	0.37	66	40	37.7	0	6	100
		4	N	0.32	3	23	88.5	0	2	100
			S	0.36	0	0	-	0	0	-
		5	N	0.32	0	25	100	0	5	100
			S	0.34	0	15	100	0	1	100

Appendix 2 (continued)

Drainage	Sample area	Tree no.	Side sampled	Bark area sampled (ft^2)	Larvae			Parent adults		
					Live	Dead	% mortality	Live	Dead	% mortality
Smith	6	1	N	0.33	19	56	74.7	0	0	-
			S	0.41	19	49	72.1	1	1	50.0
		2	N	0.38	0	0	-	0	0	-
			S	0.36	0	0	-	0	1	100
		3	N	0.25	2	7	77.8	0	0	-
			S	0.35	4	28	87.5	0	0	-
		4	N	0.30	1	8	88.9	0	1	100
			S	0.30	0	16	100	0	6	100
		5	N	0.34	0	12	100	0	5	100
			S	0.29	1	31	96.9	0	6	100
Paradise	7	1	N	0.31	2	3	60	0	5	100
			S	0.25	0	0	-	1	1	50.0
		2	N	0.35	0	0	-	0	0	-
			S	0.34	0	0	-	0	0	-
		3	N	0.44	1	3	75.0	0	2	100
			S	0.37	6	12	66.7	0	0	-
Paradise	8	1	N	0.31	0	22	100	0	6	100
			S	0.27	0	14	100	0	3	100
		2	N	0.27	0	0	-	0	0	-
			S	0.24	0	0	-	0	0	-
		3	N	0.32	0	24	100	0	3	100
			S	0.29	0	3	100	0	0	-
		4	N	0.27	0	0	-	0	5	100
			S	0.29	0	0	-	0	1	100
		5	N	0.31	3	8	72.7	0	10	100
			S	0.30	0	3	100	0	0	-

Appendix 2 (continued)

Drainage	Sample area	Tree no.	Side sampled	Bark area sampled (ft^2)	Larvae			Parent adults		
					Live	Dead	% mortality	Live	Dead	% mortality
Paradise	9	1	N	0.30	0	27	100	0	5	100
			S	0.30	0	32	100	0	5	100
		2	N	0.28	0	29	100	0	2	100
			S	0.24	4	10	71.4	0	2	100
		3	N	0.29	1	4	80.0	0	13	100
			S	0.32	1	16	94.1	0	3	100
		4	N	0.27	0	22	100	0	4	100
			S	0.29	37	10	21.3	0	2	100
		5	N	0.27	0	0	-	0	0	-
			S	0.36	3	24	88.9	0	1	100

Appendix 3.--Statistical values for the 3 major treatments.

Treatment	No. values	Mean	Median	Minimum value	Maximum value	Standard deviation	Standard error of mean	Coefficient of variation
Total larvae	86	12.5	5.2	0	71.7	15.8	1.7	126.2
Live larvae	86	3.0	0	0	44.8	8.7	0.9	290.4
% mortality*	57	71.3	76.2	0	90	22.3	3.0	31.3

*Arcsin transformation

Appendix 4.--Analysis of variance for total larvae/drainage after transformation to larvae/6X6-in. bark sample.

Source of variation	Degree of freedom	Sum of squares	Mean square	F ratio
Between	2	614.13	307.07	1.23**
Within	83	20724.20	249.69	
Total	85			

**Not significant at 0.05 rejection level.

Appendix 5.--Analysis of variance for live larvae/drainage after transformation to live larvae/6X6-in. bark sample.

Source of variation	Degree of freedom	Sum of squares	Mean square	F ratio
Between	2	421.62	210.81	2.81***
Within	83	6229.72	75.06	
Total	85			

***Not significant at the 0.05 rejection level.

Appendix 6.--Analysis of variance for percent larval mortality/drainage after arcsin transformation.

Source of variation	Degree of freedom	Sum of squares	Mean square	F ratio
Between	2	3086.33	1543.16	3.36****
Within	54	24765.62	458.62	
Total	56			

****Significant at the 0.05 rejection level.

UNITED STATES DEPARTMENT OF AGRICULTURE
FOREST SERVICE
Region 3
517 Gold Avenue, SW
Albuquerque, New Mexico 87101

5230
APR 14 1971

Mr. Robert E. Robinson, Superintendent
Bureau of Indian Affairs
Fort Apache Indian Agency
Whiteriver, Arizona 85941

Dear Mr. Robinson:

Enclosed is a biological evaluation report summarizing the results of the spruce beetle winter mortality work on the Fort Apache Indian Reservation, Arizona. The record low temperatures have reduced the epidemic population to a low level.

The present population trend does not support our prior suppression recommendations. No direct suppression is necessary at this time for the three drainages sampled.

Our recommendations may be further modified after we evaluate the remaining drainages and resample Smith Creek, since the population was marginal there. The Mount Baldy Wilderness Area will also be evaluated to determine its status and what influence its population may have on the adjoining Reservation. If so desired by the land managers, we will continue to monitor all drainages.

Sincerely,

Mark M. Johannesen

MARK M. JOHANNESEN
Assistant Regional Forester
Timber Management

Enclosure

cc: WO
WO Div. FI&DR (2)
BIA Area Office, Phoenix
RM, Ft. Collins
RM, Albuquerque
SA (3)
Regions 1, 2, 4, 5, & 6
Ing. Humberto Moreno Noriega,
Mexico